
US 60|US 70|US 191 CORRIDOR PROFILE STUDY

FLORENCE JUNCTION (SR 79) TO DOUGLAS

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Draft Working Paper 5: Strategic Solutions

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Appendix

Appendix A: Strategic Solution TypesA-1

ACRONYMS

ADOT	Arizona Department of Transportation
ADT	Average Daily Traffic
CCTV	Closed Circuit Television
CS	Candidate Solutions
DMS	Dynamic Messaging System
EB	Eastbound
FY	Fiscal Year
HOV	High Occupancy Vehicle
I	Interstate
IRI	International Roughness Index
ITS	Intelligent Transportation Systems
LCCA	Life-Cycle Cost Analysis
MP	Milepost
MPD	Multimodal Planning Division
NB	Northbound
OP	Overpass
P2P	Planning to Programming
PTI	Planning Time Index
RR	Railroad
RWIS	Road Weather Information System
SB	Southbound
SR	State Route
TTI	Travel Time Index
UP	Underpass
UPRR	Union Pacific Railroad
US	United States
VPD	Vehicles per Day
WB	Westbound
WIM	Weigh-in-Motion

1 INTRODUCTION

The Arizona Department of Transportation (ADOT) is the lead agency for this Corridor Profile Study of US Route 60|US 70: SR 79 to US 191 and US 191: US 70 to SR 80 (US 60|US 70|US 191). This study will look at key performance measures relative to the US 60|US 70|US 191 corridor, and the results of this performance evaluation will be used to identify potential strategic improvements.

The intent of the corridor profile program, and of the Planning to Programming (P2P) process, is to conduct performance-based planning to identify areas of need and make the most efficient use of available funding to provide an efficient transportation network. ADOT is conducting eleven corridor profile studies. The eleven corridors are being evaluated within three separate groupings.

The first three studies (Round 1) began in spring 2014, and encompass:

- I-17: SR 101L to I-40
- I-19: Mexico International Border to I-10
- I-40: California State Line to I-17

The second round (Round 2) of studies, initiated in spring 2015, includes:

- I-8: California State Line to I-10
- I-40: I-17 to the New Mexico State Line
- SR 95: I-8 to I-40

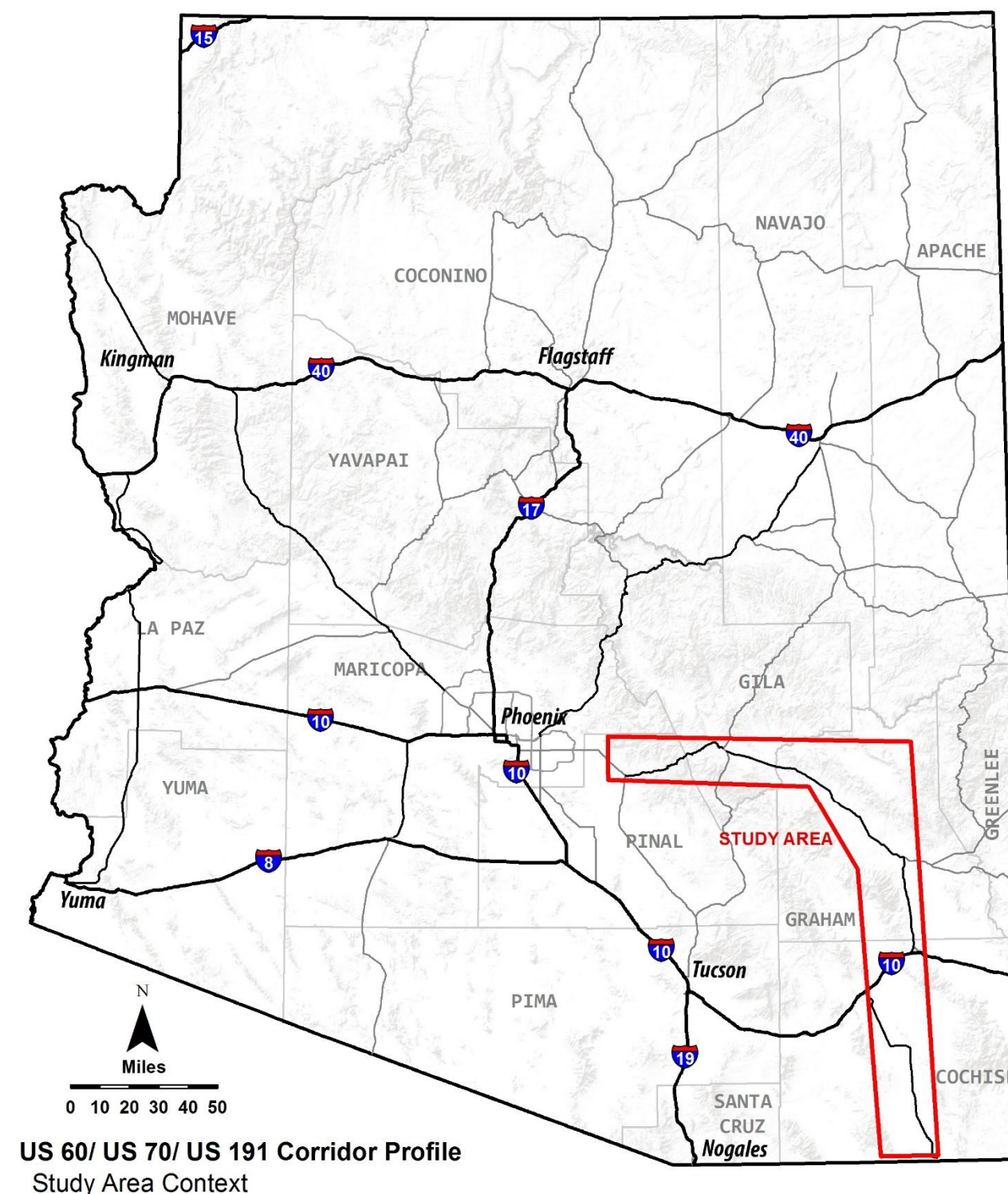
The third round (Round 3) of studies, initiated in fall 2015, includes:

- I-10: California State Line to SR 85 and SR 85: I-10 to I-8
- I-10: SR 202L to the New Mexico State Line
- SR 87/SR 260/SR 377: SR 202L to I-40
- US 60/US 70: SR 79 to US 191 and US 191: US 70 to SR 80
- US 93/US 60: Nevada State Line to SR 303L

The studies under this program will assess the overall health, or performance, of the state's strategic highways. The Corridor Profile Studies will identify candidate projects for consideration in the Multimodal Planning Division's (MPD) Planning to Programming (P2P) project prioritization process, providing information to guide corridor-specific project selection and programming decisions.

US 60|US 70: SR 79 to US 191 and US 191: US 70 to SR 80 (US 60|US 70|US 191), depicted in Figure 1, is one of the strategic statewide corridors identified and is the subject of this Round 3 Corridor Profile Study.

Figure 1: Study Area



1.1 Corridor Study Purpose

The purpose of the US 60|US 70|US 191 Corridor Profile Study is to define a comprehensive corridor planning and programming approach to help make system decisions to Arizona's transportation primary network. This is to be achieved by measuring corridor performance and using the findings to inform improvement solutions. Life-cycle cost analysis and risk assessment are to be applied in formulating corridor recommendations. This Corridor Profile Study, along with similar studies for the other ten strategic corridors, will:

- Inventory past improvement recommendations
- Assess the existing performance based on quantifiable performance measures
- Define measureable performance goals and objectives for the future of the corridor
- Propose various solutions to improve corridor performance
- Identify specific projects that can provide quantifiable benefits in relation to the performance measures
- Prioritize the projects for future implementation

1.2 Corridor Study Goals and Objectives

The objective of this study is to identify a recommended set of potential projects for consideration in future construction programs, derived from a transparent, defensible, logical, and replicable process. The US 60|US 70|US 191 Corridor Profile Study will define solutions and improvements within the study limits that can be evaluated and ranked to determine which investments offer the greatest benefit to the corridor in terms of enhancing system performance.

The following goals have been identified as the outcome of this study:

- Link project decision-making and investments on key corridors to strategic goals
- Develop solutions that address identified corridor needs based on measured performance
- Prioritize improvements that cost-effectively preserve, modernize, and expand transportation infrastructure

1.3 Working Paper 5 Overview

The objective of Working Paper 5 is to document the development of strategic solutions derived from a performance-based needs assessment of the I-8 corridor. Corridor needs were defined in Working Paper 4 through a review of the difference between baseline performance (Working Paper 2) and desired performance (Working Paper 3).

1.4 Corridor Overview

The US 60|US 70|US 191 corridor links the Mexico border at the City of Douglas and the Phoenix metropolitan area to agricultural, mining and recreational activity in southeastern Arizona. In general, all three highways are two-lane facilities designed for relatively modest traffic volumes in a rural setting. At the same time, the corridor offers some unique benefits within the Arizona circulation system that could be leveraged for increased usage as the need arises.

US 191 provides a link between Mexico and Interstate 10 (I-10), the primary east-west interstate corridor along the southern states. As a result, US 191 serves as a major freight corridor for goods moving between Mexico and the United States. Similarly, the combination of US 191 and US 70 between I-10 and Globe offers a critical connection to mining and agricultural interests located in the greater Safford and Globe areas of Graham and Pinal Counties. US 60 between Globe and SR 79 links activities within the corridor to the major population and commerce center of the Phoenix metropolitan area.

The combination of all three highways (US 60|US 70|US 191) creates a potentially significant alternative to I-10 and I-19 for travel in the eastern reaches of Arizona. A seamless connection among the three routes as a reliever could have major implications for improving international, interstate and intrastate trade along with opening access to financial and commercial distribution centers in the Phoenix area. It would also provide enhanced accessibility to tourist and recreational opportunities in southeastern Arizona.

1.5 Study Location and Corridor Segments

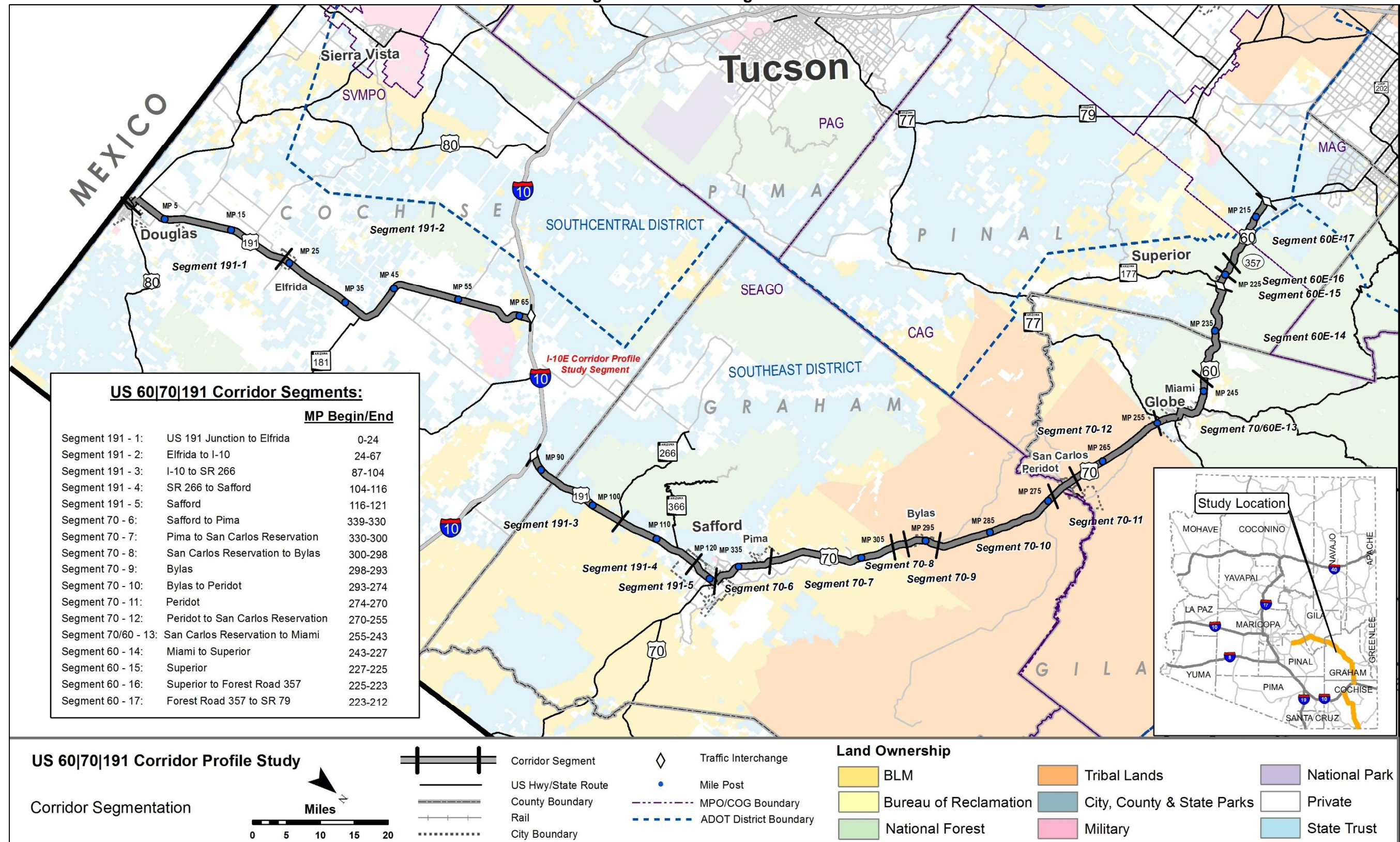
The US 60|US 70|US 191 Corridor Profile Study limits extend along US 191 from Douglas to I-10, continuing along US 191 from I-10 to Safford to the junction with US 70, then following US 70 from Safford, passing through the San Carlos Apache Reservation to Globe, and transitioning to the US 60 from Globe, through Superior to Florence Junction at the US 60|SR 79 intersection. Study segments were identified based on consideration of roadway, traffic and jurisdictional characteristics to allow for an appropriate level of analysis for segments of similar operating environments. Seventeen segments have been identified by the project team. Table 1 (Page 3) and the Corridor Map (Figure 2, Page 5) describe these segments, including general characteristics such as location, and average daily traffic (ADT).

Table 1: Corridor Segments and Descriptions

Segment	Begin	End	Approximate Begin Milepost	Approximate End Milepost	Approximate Length (miles)	Through Lanes	2014 Average Annual Daily Traffic Volume (vpd)	Character Description
<i>US 191 (MP 0 to MP 66.84 and MP 87.48 to MP 121.02)</i>								
191B – 1A	U.S. Mexico Border	US 191 Junction	0	1	1	4	8,000 – 13,000	This segment begins at the Douglas Port of Entry and continues north along US 191B (Pan American Avenue) until the intersection with US 191 (16th Street). The high traffic counts can be attributed to the international border crossing as well as the mixed industrial/commercial/residential uses along the route. This segment will not be included in this study as the facility is currently being turned over from ADOT to Douglas.
191-1	US 191B Junction	Elfrida	0	24	24	2	1,000 – 2,000	Starting from MP 0 along US 191, this segment is primarily rural in nature, but is the only route to the Bisbee-Douglas International Airport.
191-2	Elfrida	I-10	24	67	43	2	1,000 – 2,000	Beginning in Elfrida, a census-designated place, this segment connects smaller agricultural communities to each other and I-10.
191-3	I-10	SR 266	87	104	17	4	2,000	No known developments exist along this segment however, it does connect the Arizona State Prison at Fort Grant to I-10 via SR 266.
191-4	SR 266	Safford City Limit	104	116	12	2	3,000 – 7,000	Land along this segment is primarily owned by the Bureau of Reclamation and is therefore undeveloped. The segment begins at SR 266 and ends at approximately the southern limits of Safford. Traffic numbers in this segment increase due to the development south of Safford.
191-5	Safford City Limit	US 70 Junction	116	121	5	4	8,000 – 9,000	This segment starts at approximately the southern limits of Safford and ends at the junction with US 70. The segment is differentiated by jurisdiction and change in route along the corridor rather than any changes in terrain or traffic.
<i>US 70 (MP 252.14 to MP 314.21 Back = MP 325.31 Ahead to MP 339.46)</i>								
0-6	US 191 Junction	Pima	339	330	9	4	5,000 – 23,000	Beginning at the junction with US 191 in Safford and ending at the northern limit of Pima, this segment has very high traffic volumes which can be attributed to the higher density of surrounding communities and agricultural/mining operations. A large majority of the land abutting the route is privately owned.
70-7	Pima	San Carlos Apache Reservation	330	300	19	2	3,000 – 5,000	This segment connects the western limit of Pima to the eastern edge of the San Carlos Apache Reservation. A majority of the land abutting US 70 is privately owned and used for agricultural purposes. Milepost equation MP 314.21 Back = MP 325.31 Ahead occurs within this segment.
70-8	San Carlos Apache Reservation	Bylas	300	298	2	2	3,000	Beginning at the eastern limits of the San Carlos Apache Reservation, this short segment terminates at the eastern limits of Bylas.
70-9	Bylas	Bylas	298	293	5	2	3,000	Bylas is a census-designated place within the San Carlos Apache Reservation. The boundary of this segment was determined by the extent of development and not necessarily the jurisdictional limits.

Segment	Begin	End	Approximate Begin Milepost	Approximate End Milepost	Approximate Length (miles)	Through Lanes	2014 Average Annual Daily Traffic Volume (vpd)	Character Description
70-10	Bylas	Peridot	293	274	19	2	3,000	This segment begins at the western extent of development in Bylas and extends to the eastern limits of development in Peridot. The segment is within the San Carlos Reservation and has low traffic volume.
70-11	Peridot	Peridot	274	270	4	2	3,000	The segment starts at the new medical center at the eastern limits of Peridot and extends west to the high school. It is differentiated by Graham/Gila County jurisdiction rather than changes in terrain or traffic.
70-12	Peridot	San Carlos Apache Reservation	270	255	15	2	4,000 – 7,000	Beginning at the Peridot High School and continuing to the western limit of the San Carlos Apache Reservation, this segment is differentiated by jurisdiction rather than any changes in terrain or traffic.
70|60-13	San Carlos Apache Reservation	Miami	255	243	12	4	3,000 – 28,000	Beginning at the western limits of the San Carlos Apache Reservation, this segment goes through the City of Globe, Claypool and Miami. Although this segment includes US 70 and US 60, there is no change in cross section therefore, the segment is differentiated by jurisdiction rather than any other changes. Higher traffic counts are due to the junction of US 60 and US 70 along with higher traffic counts and the proximity of large mines.
<i>US 60 (MP 212.17 to MP 252.23)</i>								
60-14	Miami	Superior	243	227	16	2	7,000 – 9,000	Beginning at the western limits of Miami and extending to the eastern limits of Superior, this segment bisects the Tonto National Forest. The high traffic volume can be attributed to a significant number of regular commuters in both directions (Valley to Globe) and tourist traffic.
60-15	Superior	Superior	227	225	2	2	10,000	This segment starts and ends at approximately the eastern and western limits of Superior. This segment is differentiated by jurisdiction rather than any changes in terrain or traffic.
60-16	Superior	Forest Road 357	225	223	2	2	9,000	This segment is bounded by the Tonto National Forest and is differentiated by the number of thru east and west lanes rather than changes in terrain or jurisdiction.
60-17	Forest Road 357	SR 79	223	212	11	2	10,000	Although this segment is generally flat in nature, it is differentiated by the number of thru lanes, compared to 60-16. Beginning at State Forest Road 357, this segment terminates at the interchange with SR 79.

Figure 2: Corridor Segmentation



2 SUMMARY OF CORRIDOR NEEDS

2.1 Summary of Needs

Working Paper 4 documented the framework for the performance-based needs assessment process and the results for the US 60|US 70|US 191 corridor. The needs in each performance area were classified as either None, Low, Medium, or High based on how well each segment performed in the existing performance analysis conducted in Working Paper 2. The needs for each segment were combined to numerically estimate the average level of need for each segment of the corridor.

During the Corridor Performance Goals and Objectives establishment for US 60|US 70|US 191 (Working Paper 3), the Mobility, Safety and Freight Performance Areas were identified as Emphasis Areas, reflecting the primary future functionality of the corridor as a significant facility for the movement of international goods. Therefore, a weighting factor of 1.50 was applied to those needs during the calculation process in order to ensure appropriate attention to the developing commercial route.

The needs for the US 60|US 70|US 191 corridor are summarized below. Figure 2 shows all needs identified in the assessment, ranging from None to High.

Pavement Performance Area

- Of the 214 corridor miles, approximately 119 miles (55%) exhibit a “Low” level of pavement need and 17 miles (17%) exhibit “Medium” level of pavement need.
- Pavement hot spot failure needs were identified for 17 miles on US 191, 3 miles on US 70, and 3 miles on US 60.
- A high level of historical investment has occurred on Segments 70-9 and 70-10 through the San Carlos Indian Reservation and a medium level of historical investment has occurred through the remaining corridor segments, excluding Segment 191-1.

Bridge Performance Area

- Bridge needs were identified on three segments of the corridor, 43 miles (20%) with a “Medium” level of bridge need and 28 miles (13%) with a “High” level of bridge need.
- Eight bridges showed potential repetitive investment issues and may be candidates for life-cycle cost analysis to evaluate alternative solutions.
- Three bridges have bridge ratings of 4: Pinal Creek Bridge (No. 266), Waterfall Canyon Bridge (No. 328), and Queen Creek Bridge (No. 406).
- One bridge had a bridge rating of 5: Pinal Creek Bridge (No. 36).
- Nine bridges were defined as hot spots since they had multiple bridge ratings of 5 or less.
- Of the nine hot spot bridges, five also showed repetitive investment issues. These included the Pinal Creek Bridge (No. 36), Pinal Creek Bridge (No. 266), Pinto Creek Bridge (No. 351), Waterfall Canyon Bridge (No. 328), and Queen Creek Bridge (No. 406).

Mobility Performance Area

- Mobility Performance is an Emphasis Area for the US 60| US 70| US 191 corridor, giving it a heavier weight in the analysis.
- A low level of mobility need was identified on 168 miles (79%) of the US 60| US 70| US 191 corridor and a medium level of mobility need was identified on 33 miles (15%) of the corridor.
- Contributing factors include to reduced mobility performance includes:
 - Closures of the roadway due to flooding (US 191 at MP 53 and MP 66),
 - A concentration of short term closures due to incidents/accidents throughout corridor,
 - A significant number of extended duration closures on US 60 from MP 225 – 228,
 - Mountainous grades with a lack of passing and climbing lanes on US 60 from MP 227 – 243,
 - Limited passing, acceleration and deceleration on rolling terrain on US 70 from MP 255 – 330,
 - Rockfall on US 60 caused repeated incidents of delay and closures between MP 228 – 248,
 - Weather related delay and closures on US 60 between MP 224-243 due to snow, ice and impassable conditions,
 - Limited bicycle accommodation on much of the corridor, on US 191 from MP 24 – 104 and MP 116 – 121, and US 60/70 from MP 298 – 243.

Safety Performance Area

- Safety Performance is an Emphasis Area for the US 60| US 70| US 191 corridor, giving it a heavier weight in the analysis.
- A High level of safety need was identified for 67 miles (31%) of the corridor and Low level of safety need identified for 37 miles (17%) of the corridor.
- Contributing factors to the safety need include:
 - Fatalities on SB US 191 in the vicinity of MP 91 – 93, which were single vehicle roll over crashes involving high speed.
 - On both US 191 and US 70 in the Safford area, factors included lack of pedestrian lighting and pedestrian facilities, traffic control device reflectivity, intersection geometry, and high traffic volumes
 - US 70 from Bylas to Peridot, MP 293 – 274, long stretch of rolling terrain with limited passing lanes and rest areas, with safety factors including shoulder conditions and width, traffic control device reflectivity, clear zone slope and obstructions, and intersection geometry

- US 60/US 70 from Peridot to Superior, lack of passing and climbing lanes, deceleration lanes, pedestrian facilities, intersection geometry, high traffic volumes in urbanized areas with high volume of trucks and motorcycles from MP 227 - 243
- US 60/70 from Globe to Superior, MP 227 – 255, high crash rate due to shoulder conditions, shoulder width, high speeds, clear zone slope and obstructions, high traffic volumes
- US 60 WB from Superior to Florence Junction, MP 223 -212, with safety factors including reduced shoulder conditions and width and potential clear zone slope and obstructions.

Freight Performance Area

- Freight Performance is an Emphasis Area for the US 60| US 70| US 191 corridor, giving it a heavier weight in the analysis.
- A Low level of freight needs was identified on 15 miles (7%) of the US 60| US 70| US 191 corridor and a High level of freight need was identified on 116 miles (54%) of the corridor.
- High level of delay related to the Planning Time Index (PTI) contributed to elevated freight needs for NB/SB US 191 MP 0 – 104, EB/WB US 60 MP 225 – 255, and EB US 70 MP 270 – 255.
- The number of closures on US 60| US 70| US 191 due to incidents/accidents or obstructions/ hazards are above statewide average in the following areas:
 - US 191 MP 0 – 67 including flooding at MP 53 and MP 66
 - US 191 MP 43 (Border Patrol Check Point)
 - Concentration of short term closures due to incidents/accidents at the following locations:
 - Incidents/accidents US 191 MP 115 – 120
 - US 60 from MP 233 – 242,
 - US 60 from MP 228 – 231.7 (with a high concentration of incidents at MP 230), and
 - US 60 from MP 224 – 227
 - Significant number of extended duration closures on US 60 from MP 225 – 228
 - Mountainous grades with a lack of passing and climbing lanes on US 60 from MP 227 - 243
 - Limited passing, acceleration and deceleration on rolling terrain on US 70 MP 255 - 330
 - Rockfall on US 60 caused repeated incidents of delay and closures between MP 228 – 248
 - Weather related delay and closures on US 60 between MP 224-243 due to snow, ice and impassable conditions
- Clearance restrictions exist at Pinal SPRR UP MP 253.63 (No. 562, height of 15.84') and Queen Creek Tunnel MP 228.47 (height of 13.03').

2.2 Strategic Investment Areas

In an effort to focus on the most significant issues identified throughout the corridor, only needs that will result in strategic investment will be considered for solutions. Needs that do not require strategic investment, as identified through this process, will be removed from further analysis.

High and Medium segment level needs, as well as any segment regardless of level of need with an identified Hot Spot are considered candidates for strategic investment, for which solutions will be developed. Segments with None or Low levels of need without any apparent Hot Spots are not considered candidates for strategic investment and will likely be addressed through other ADOT programming processes.

Figure 4 illustrates locations on the US 60| US 70| US 191 corridor for which solutions will be identified.

Figure 3: Summary of Corridor Needs

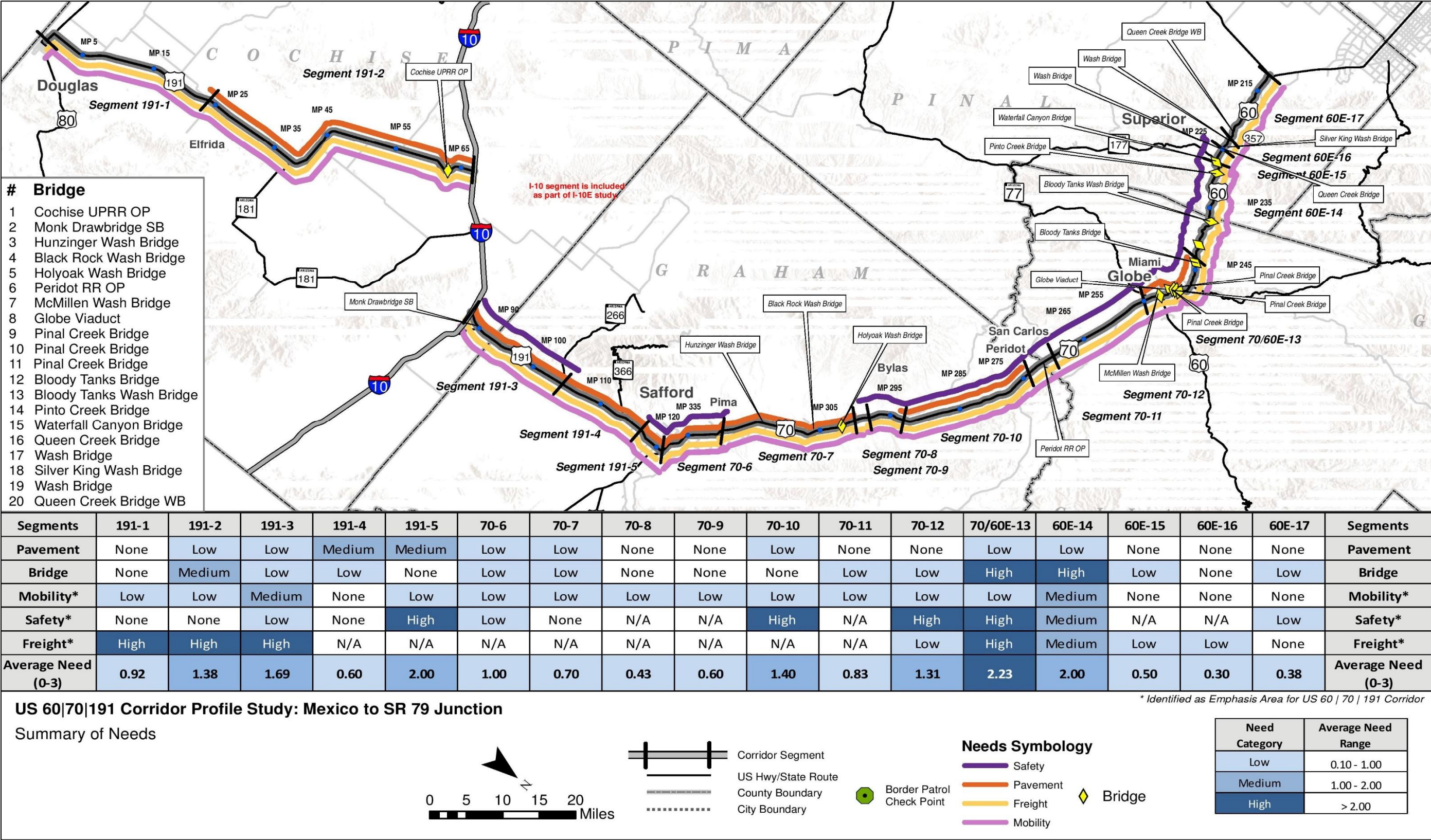
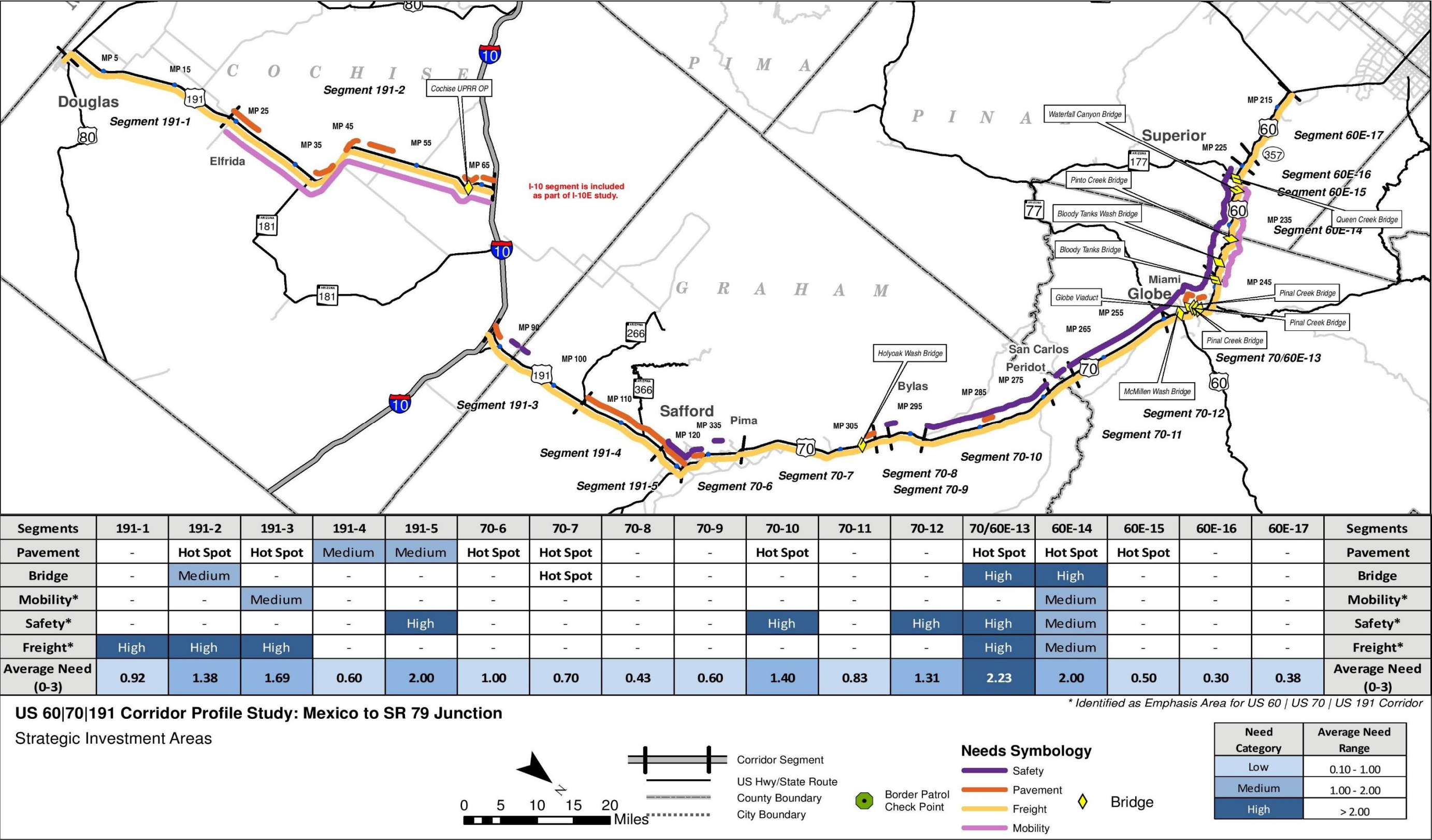


Figure 4: Strategic Investment Areas



3 STRATEGIC INVESTMENT AREA SCREENING

This section examines the needs identified in Section 2 that qualify for strategic investment and determines if the needs in those locations require action. Table 2 notes if each potential strategic need location will advance to solution set development, and if not the reason for screening out. Locations advancing to solutions development are marked with Yes (Y); locations not advancing are marked with No (N) and grayed out.

In some cases, needs that have been identified will not advance to solutions set development and will be screened out from further consideration because it has been or will be addressed through other measures including:

- A project has already been programmed to address this need.
- The need is a result of a pavement or bridge hotspot that does not show high levels of historical investment issues as identified in Working Paper #4. These hotspots will likely be addressed through other ADOT programming means.
- A bridge is not a hotspot but is located within a segment with a Medium or High level of need. This bridge will likely be addressed through current ADOT bridge maintenance and preservation programming processes.
- The need is determined to be ‘non-actionable’ as is the case in Segment 19-3, where the Freight need is due to the presence of a US Customs and Border Patrol Checkpoint. There is no solution to mitigate this need because all traffic must stop for inspection. Therefore, no improvement can be recommended at this time.
- The conditions/characteristics of the location have changed since the performance data was collected that was used to identify the need.

The remainder of the study will focus on developing appropriate solutions for the advancing locations. The table provides specific information about the needs in each segment that will be considered for strategic investment. The table identifies the level of need – either Medium or High and the presence of hotspots, if they are identified in a segment without a Medium or High level of need, which also triggers consideration for a strategic investment. Each area of need has been assigned a Location Number to help document and track specific locations that are being considered for strategic investment throughout this process.

Table 2: Strategic Investment Area Screening

Segment	Level of Strategic Need					Location #	Type	Need Description	Advance (Y/N)	Screening Description
	Pavement	Bridge	Mobility	Safety	Freight					
191-1 (MP 0 – 24)	-	-	-	-	High	L1	Freight	Congestion/delay related to trucks due to high PTI in both directions. Friction with large trucks, oversized vehicles and Douglas Port of Entry.	N	No programmed project to address freight need because freight need was due to weigh station.
191-2 (MP 24-67)	Hot Spot	Medium	-	-	High	L2	Pavement	Hot Spot in NB lanes MP 48-51 (Excessive Cracking)	N	A medium level of historical investment has occurred on Segment 191-2 according to PeCOS data and recent pavement preservation projects. No pavement preservation projects are currently programmed for this portion of the segment. Anticipated to be addressed through current ADOT pavement maintenance and preservation programming processes.
						L3	Bridge	Medium level of need related to deck rating =5. The bridge was not identified as a Hot Spot. Cochise UPRR OP (MP 62.88, #157)	N	Structure does not have a historical rating issue according to the historical review, therefore it is not considered for strategic investment. Issues related to this bridge such as narrow width, use by oversized vehicles, and other safety concerns have been observed. These items will potentially be addressed in the solutions identified for need location L4.
						L4	Freight	Congestion/delay related to trucks due to high PTI in the southbound direction.	Y	
191-3 (MP 87-104)	Hot Spot	-	Medium	-	High	L5	Pavement	Hot Spot in SB lanes MP 87-88 (Excessive Cracking)	N	A medium level of historical investment has occurred on Segment 191-3. One future pavement preservation project was identified between MP 86.89 - 90.11, ADOT Five Year Program (H7866-FY18). Anticipated to be addressed through current ADOT pavement maintenance and preservation programming processes.
						L6	Mobility	NB direction, high delay due to a few very long duration closures.	N	No programmed project to address mobility need. This segment was improved to a four-lane divided facility in 2009, its ultimate cross section. Current and future traffic volumes can be accommodated by the four-lane roadway. High closure durations are likely due to the location of the traffic counter providing data (within an intersection).
						L7	Freight	Congestion/delay related to trucks, with high TTI and PTI in both directions, primarily due to a few very long duration closures.	N	No programmed project to address freight need. This segment was improved to a four-lane divided facility in 2009, its ultimate cross section. Current and future traffic volumes can be accommodated by the four-lane roadway. High closure durations are likely due to the location of the traffic counter providing data (within an intersection).
191-4 (MP 104-116)	Medium	-	-	-	-	L8	Pavement	Hot Spot in NB lanes MP 105-107 (High IRI)	N	A medium level of historical investment has occurred on Segment 191-4. No pavement preservation projects are currently programmed for this portion of the segment. Anticipated to be addressed through current ADOT pavement maintenance and preservation programming processes.

Legend: Strategic investment area screened out from further consideration

Segment	Level of Strategic Need					Location #	Type	Need Description	Advance (Y/N)	Screening Description
	Pavement	Bridge	Mobility	Safety	Freight					
191-5 (MP 116-121)	Medium	-	-	High	-	L9	Pavement	Hot Spot in NB lanes MP 120-121 (High IRI)	N	The segment had an initial need of medium and one hot spot was identified. One programmed projects exists in this segment, MP 116-118, ADOT Five Year Program FY16 (H8700). Anticipated to be addressed through current ADOT pavement maintenance and preservation programming processes.
						L10	Safety	Lack of pedestrian lighting and pedestrian facilities, traffic control device reflectivity, intersection geometry, and high traffic volumes. 40% involved pedestrians, 20% involved pedestrians not using the crosswalk, 40% involved left turns, 40% involved failure to yield right-of-way, 40% occurred in dark unlighted condition, and 40% occurred in dark lighted conditions, and 60% involved drugs or alcohol. The higher concentration of incidents can be associated with the urbanized area of Safford in addition to the limited controlled intersection. Project H8324 is programmed and will support and increase of safety and mobility through the US 191/US 70 intersection.	Y	
70-6 (MP 339-343)	Hot Spot	-	-	-	-	L11	Pavement	Hot Spot in WB lanes MP 336-337 (High IRI)	N	A low level of historical investment has occurred on Segment 70-6. No pavement preservation projects are currently programmed for this portion of the segment. Anticipated to be addressed through current ADOT pavement maintenance and preservation programming processes.
70-7 (MP 330-300)	Hot Spot	Hot Spot	-	-	-	L12	Pavement	Hot Spot in WB lanes MP 300-301 (Excessive Cracking)	N	A low level of historical investment has occurred on Segment 70-6. A pavement preservation chipseal is programmed.
						L13	Bridge	Hot Spot at Holyoak Wash Bridge (MP 302.53, #514)	N	Structures do not have a historical rating issue according to the review, therefore they are not considered for strategic investment. Anticipated to be addressed through current ADOT bridge maintenance and preservation programming processes.
70-8 (MP 300 - 298)	-	-	-	-	-	No Strategic Needs Identified				

Legend: Strategic investment area screened out from further consideration

Segment	Level of Strategic Need					Location #	Type	Need Description	Advance (Y/N)	Screening Description
	Pavement	Bridge	Mobility	Safety	Freight					
7-9 (MP 298 – 293)	-	-	-	-	-	No Strategic Needs Identified				
70-10 (MP 293-274)	Hot Spot	-	-	High	-	L14	Pavement	Hot Spot in WB lanes MP 283-284 (Hot Spot failure, High IRI). District is currently seeking funding for pavement preservation.	Y	
						L15	Safety	The high level of initial and final need is associated with the high ratio of fatal crashes compared to those resulting in incapacitating injuries. This segment has rolling hills and valleys with few safe passing opportunities. 40% involved collision with motor vehicle, 40% involved overturning, 60% were single vehicle crashes, 20% was head on, 20% drove in the opposing lane, 20% driver inattention/distraction, 40% dark unlighted conditions.	Y	
70 – 11 (MP 274 – 270)	-	-	-	-	-	No Strategic Needs Identified				
70-12 (MP270-255)	-	-	-	High	-	L16	Safety	The high level of initial and final need is associated with the high ratio of fatal crashes compared to those resulting in incapacitating injuries. 50% involved a pedestrian, 50% were head on collisions, 25% drove in opposing lane, 25% involved unsafe passing, 50% involved crossing centerline, 25% involved drugs/alcohol.	Y	

Legend: Strategic investment area screened out from further consideration

Segment	Level of Strategic Need					Location #	Type	Need Description	Advance (Y/N)	Screening Description
	Pavement	Bridge	Mobility	Safety	Freight					
70/60E-13 (MP255-243)	Hot Spot	High	-	High	High	L17	Pavement	Hot Spot in EB lanes MP 247-248 (Hot Spot Failure) and Hot Spot in EB lanes MP 249-251 (Hot Spot Failure and Excessive Cracking)	N	A medium level of historical investment has occurred on Segment 191-2. No pavement preservation projects are currently programmed for this portion of the segment. Anticipated to be addressed through current ADOT pavement maintenance and preservation programming processes.
						L18	Bridge	Pinal Creek Bridge MP 250.37 (#549)	N	No historical rating issues.
						L19	Bridge	Pinal Creek Bridge MP 249.80 (#36)	Y	
						L20	Bridge	Pinal Creek Bridge MP 249.64 (#266)	Y	
						L21	Bridge	Bloody Tanks Bridge MP 243.71 (#173)	N	No historical rating issues.
						L22	Safety	Hot Spots at EB/WB MP 246-249; The higher concentration of incidents can be associated with the urbanized areas of Globe and Miami. 11% collisions with fixed object, 9% with pedestrian, 29% involved rear end collision, 26% involved failure to yield right of way, 20% driver inattention/distraction, 17% speed too fast for conditions, 23% in dark lighted conditions, 6% in dusk conditions, 9% ran off the road to the right.	Y	
						L23	Freight	High EB PTI (delay), can be contributed to signals located on steep grades in the EB direction with significant delay if trucks stop at signal.	Y	
						L24	Freight	Bridge clearance at Pinal SPRR UP (MP 253.63, #0562) (15.84')	Y	

Legend: Strategic investment area screened out from further consideration

Segment	Level of Strategic Need					Location #	Type	Need Description	Advance (Y/N)	Screening Description
	Pavement	Bridge	Mobility	Safety	Freight					
60E-14 (MP243-227)	Hot Spot	High	Medium	Medium	Medium	L25	Pavement	Hot Spot in WB lanes MP 229-233 (High IRI) and WB MP 235-236 (High IRI)	N	A medium level of historical investment has occurred on Segment 191-2. No pavement preservation projects are currently programmed for this portion of the segment. Anticipated to be addressed through current ADOT pavement maintenance and preservation programming processes.
						L26	Bridge	Pinto Creek Bridge MP 238.25 (#351)	N	Programmed FY18
						L27	Bridge	Queen Creek Bridge MP 227.71 (#406). Project Assessment is currently underway for scoping improvements.	Y	
						L28	Bridge	Waterfall Canyon Bridge MP 229.50 (#328)	Y	
						L29	Bridge	Queen Creek Tunnel MP 228.47 (#407)	N	Non-actionable per discussion with District
						L30	Mobility	PTI/delay, mountainous terrain, high number of closures/duration	Y	
						L31	Safety	Hot Spots at WB: MP 227-229 and EB: MP 232-234; The high initial and final need can be associated with the mountainous terrain along this section of the corridor. 38% collision with fixed object, 14% head on, 38% speed too fast for conditions, 24% dark unlighted conditions, 3% dark lighted, 14% wet/slush conditions, 45% ran off road to the right, 28% crossed centerline, 24% under the influence of drugs/alcohol	Y	
						L32	Freight	High EB TTI, High EB/WB PTI, and High Closure Duration EB due to mountainous grades	Y	

Legend: Strategic investment area screened out from further consideration

Segment	Level of Strategic Need					Location #	Type	Need Description	Advance (Y/N)	Screening Description
	Pavement	Bridge	Mobility	Safety	Freight					
60E-15 (MP227-225)	Hot Spot	.	.	.	.	L33	Pavement	WB MP 226-227	N	A medium level of historical investment has occurred on Segment 191-2. This pavement will be replaced under the Silver King to Superior Streets (H7900) project.
60E-16 (MP225-223)	.	.	.	.	.	No Strategic Needs Identified				
60E-17 (MP223-212)	.	.	.	.	.	No Strategic Needs Identified				

Legend: Strategic investment area screened out from further consideration

4 CANDIDATE SOLUTIONS

The principal objective of the corridor profile study is to identify performance-based strategic solutions (investments) to help inform decision-making processes. This will enable ADOT to direct available funding resources to maximize the performance of the State’s key transportation corridors. The corridor profile process is designed to work together with P2P by assigning strategic solutions to one of three categories for investment:

- Preservation
- Modernization
- Expansion

The performance needs previously documented in Working Paper 4 serve as the foundation for developing strategic solutions for corridor preservation, modernization, and expansion. Strategic investments are not intended to be a substitute or replacement for traditional ADOT project development processes where various candidate projects are developed for consideration in programming in the P2P Link process. Rather, strategic solutions are intended to complement ADOT’s traditional project development processes through a performance-based process to address needs in one or more of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Strategic solutions developed for key corridors will be considered along with other candidate projects in the ADOT programming process.

4.1 Characteristics of Strategic Solutions

For the purposes of the corridor profile process, strategic solutions include the following characteristics:

- Do not recreate or replace results from normal programming processes.
- May include programs or initiatives, areas for further study, and infrastructure projects.
- Address elevated levels of need (high or medium) and hotspots.
- Focus on investments in Modernization projects (to optimize current infrastructure).
- Address overlapping needs.
- Reduce costly repetitive maintenance.
- Extend operational life of system and delay expansion.
- Leverage programmed projects that can be expanded to address other strategic elements.
- Provide measureable benefit (benefit/cost ratio, risk, LCCA, performance system, etc.).

4.2 Strategic Solutions Types

Establishing uniform solution types will enable the corridor profile process to compare proposed solutions on and across corridors to determine effectiveness at improving performance, including cost and risk comparisons to be undertaken in subsequent tasks. Appendix A provides a list of the preliminary solutions currently proposed for the corridor profile studies which are separated into the three funding categories (Preservation, Modernization, or Expansion).

4.3 Candidate Solutions

The final step in this task is to identify candidate solutions that will be submitted for further analysis through the Life Cycle Cost and Risk Analysis tasks. The project team accessed a variety of resources to identify solutions to address strategic investment areas:

- Field reviews
- Observable trends from performance analysis
- Discussions with districts
- ADOT technical groups
- Review previous reports
- National best practices
- Professional judgment

Table 3 identifies each deficient location that has been assigned a solution, with a number (i.e. CS 191.1, 191.2, etc.) based on the solution types in the previous section. The assigned candidate solution (CS) number will provide tracking capability through the rest of the process. The strategic investment areas and their related solutions are shown in Figure 4.

In some cases, multiple solutions are proposed for a single location. The solutions that are proposed to address the same need location will be advanced to the Life Cycle Cost and Benefit Cost Analysis evaluation in Task 6 with the intent of selecting one recommended solution per location to advance to the Risk Analysis evaluation. In locations where only one option has been developed, the next step will be to advance that solution directly to the Risk Analysis evaluation where they will be prioritized.

Solutions that are recommended to expand or modify the scope of an already programmed project are noted and will not be advanced to the Life Cycle Cost, Benefit Cost, or Risk Analysis evaluation. These solutions will be directly recommended for programming because they are not considered standalone. These recommendations should be considered as part of scope expansion in order to fully address identified needs within the corridor. They will be carried forward into the final study recommendations.

Table 3: Candidate Construction Program Solutions

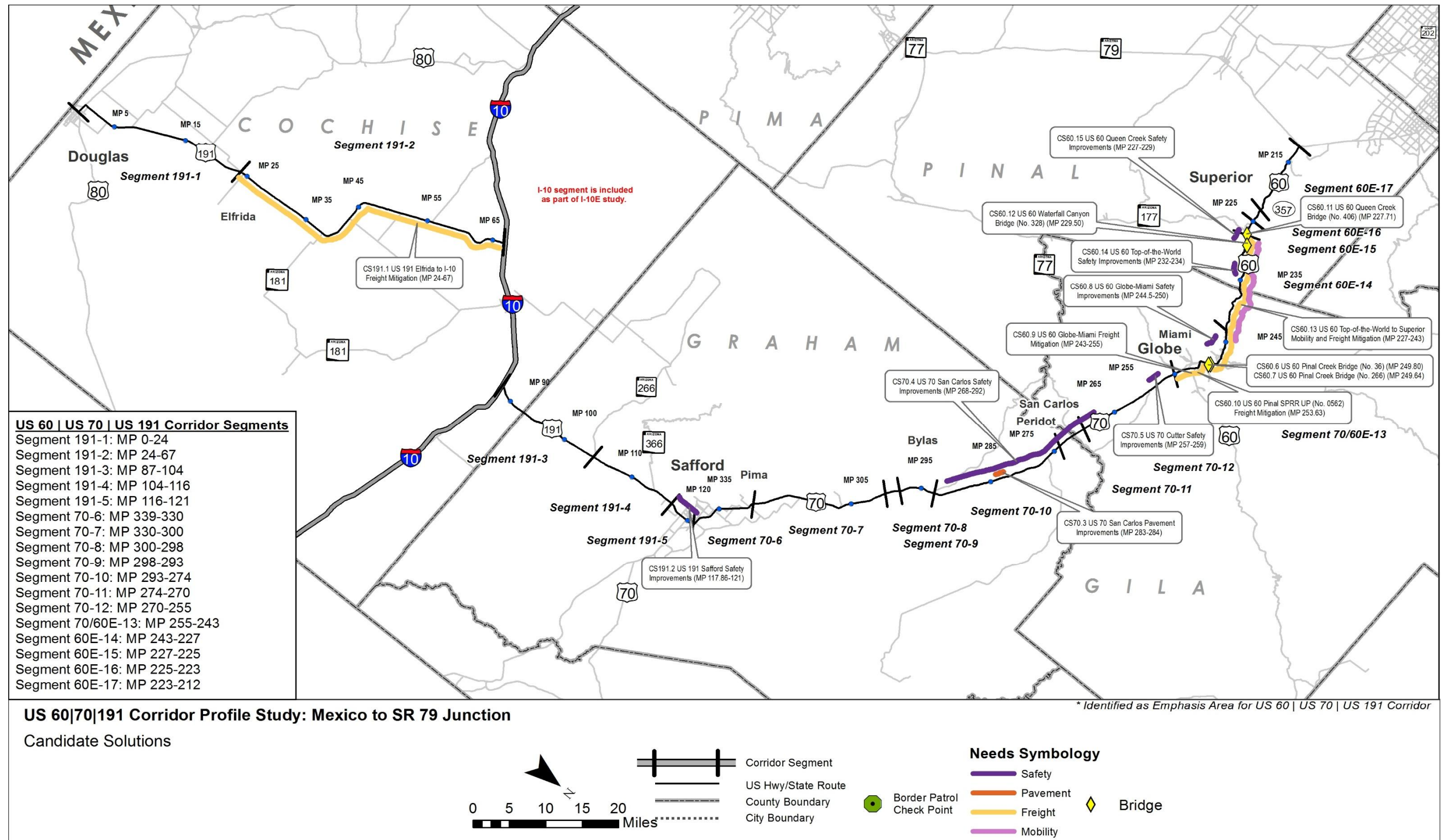
Solution #	Location #	BMP	EMP	Name	Option	Scope	Investment Category Preservation (P) Modernization (M) Expansion (E)
CS191.1	L4	24	67	US 191 Elfrida to I-10 Freight Mitigation	A B	Widen shoulders, realign roadway from MP 59.9 to MP 64.2, and replace Cochise RR bridge Construct passing lanes, realign roadway from MP 59.9 to MP 64.2, and replace Cochise RR bridge	M
CS191.2	L10	117	121	US 191 Safford Safety Improvements	-	Intersection improvements, focusing on: <ul style="list-style-type: none"> Armory Road Intersection (MP 118): Improve signal visibility, install warning signs with beacons in advance of intersection Discovery Park Intersection (MP 119): Improve signal visibility, dynamic speed warning signs Lone Star Intersection (MP 119.5): Install signal with crosswalk and lighting, install warning signs with beacons in advance of intersection 16th Street (MP 120.5): Install warning signs with beacons in advance of intersection 	M
CS70.3	L14	283	284	US 70 San Carlos Pavement Improvement	A B	Replace Pavement Rehabilitate Pavement	P P
CS70.4	L15	268	292	US 70 San Carlos Safety Improvements	-	Install high-visibility edge line striping Install high-visibility signage Install Warning Signs with Beacons at Curves and Speed Feedback Signs, (MP 292, 280, 278.5) Install Warning Signs and Speed Feedback Signs entering high pedestrian area (WB MP 273, EB 269) Install centerline rumble strip Install rumble strip Shoulder widening and install safety edge Construct passing lanes (2 miles EB and 2 miles WB) Formalize pullouts (signage, ROW for pullouts) (WB MP 274.5, EB MP 279, EB MP 289, WB 292)	M

Solution #	Location #	BMP	EMP	Name	Option	Scope	Investment Category Preservation (P) Modernization (M) Expansion (E)
CS70.5	L16	257	259	US 70 Cutter Safety Improvements	-	Widen shoulder, install rumble strip and safety edge Improve Signal Reflectivity at Route 6 Install warning signage in advance of Route 6 (EB and WB), EB MP 258 and WB MP 259 Construct Center lane (MP 258 – 259) Install Lighting	M
CS60.6	L19	249.80		US 60 Pinal Creek Bridge (No. 36)	A B	Replace bridge Rehabilitate bridge	M M
CS60.7	L20	249.64		US 60 Pinal Creek Bridge (No. 266)	A B	Replace bridge Rehabilitate bridge	M M
CS60.8	L22	244.5	250	US 60 Globe-Miami Safety Improvements	-	Install Lighting Install Speed Feedback Signs (MP 246 - 250) Install Warning Signs with Beacons in advance of 188 intersection Widen shoulder and install rumble strip and safety edge Rehabilitate Pavement (MP 249 – 251)	M
CS60.9	L24	253.63	253.63	US 60 Pinal SPRR UP (No. 0562) Freight Mitigation	A B C	Replace bridge Provide ramp Reprofile mainline	M
CS60.10	L27	227.71		US 60 Queen Creek Bridge (No. 406)	A B	Replace bridge Rehabilitate bridge	P
CS60.11	L28	229.50	229.50	US 60 Waterfall Canyon Bridge (No. 328)	A B	Replace bridge Rehabilitate bridge	P
CS60.12	L30/L32	227	243	US 60 Top-of-the-World to Superior Mobility and Freight Mitigation MP 227-243	A B C	Widen shoulder, install rock-fall mitigation and dynamic weather warning beacons Climbing/Passing Lanes (2 miles EB and 2 miles WB), install rock-fall mitigation and dynamic weather warning beacons Construct New 4-lane divided (using 2 existing-lanes for one direction)	M M E

Solution #	Location #	BMP	EMP	Name	Option	Scope	Investment Category Preservation (P) Modernization (M) Expansion (E)
CS60.13	L31	232	234	US 60 Top-of-the-World Safety Improvements	-	Widen shoulder Install guardrail Construct passing/climbing lane (2 miles EB and 2 miles WB) Install warning signage and speed feedback signs Install high visibility edge line striping Improve sign visibility Install centerline rumble strip	M
CS60.14	L31	227	229	US 60 Queen Creek Safety Improvements	-	Widen shoulder and install rumble strip and safety edge Install guardrail Construct passing/climbing lane (2 miles EB and 2 miles WB) Install warning signage and speed feedback signs Install high visibility edge line striping Improve sign visibility Install centerline rumble strip	M

- "None" indicates only one solution is being proposed and no options are being considered

Figure 5: Candidate Solutions



4.4 Other Corridor Recommendations

In addition to the recommended construction program solutions identified in Table 3, this corridor profile study recommends that ADOT consider additional strategies for US 60| US 70| US 191 that are compatible with the long range vision to increase safety and support truck and freight movements:

- Poor visibility of crossroads in the Safford area is causing a higher level of crashes. A Sign Visibility Study in the Safford area along US 191 is recommended to identify locations with potential to improve retroreflectivity.
- Road Safety Assessments are recommended in Peridot, Cutter and Globe to identify safety improvements, specifically pedestrian circulation and access needs in Peridot.
- Access Control Studies in Peridot (MP270 – 274) and Globe-Miami (MP 243 – 255) are recommended to identify potential for access consolidation, signage, etc to reduce friction and improve safety.
- Recommend Superior – Globe DCR/Feasibility Study
- Recommend San Carlos Area (MP 268 – 292) Superelevation Study

4.5 Policies and Initiatives

In addition to location specific needs, general corridor and system wide needs were also identified through the corridor profile process. While these needs are more overarching and cannot be individually evaluated through this process, it is important to document them as well. Therefore, a recommended policies and initiatives list was developed for consideration when programming future projects not only on I-8, but across the entire state highway system where the conditions are applicable. The following list was derived from the Corridor Profile Studies and will be expanded to include recommendations from subsequent corridors as they are developed. Appendix A defines these policies and recommendations in more detail and describes how and where they are applicable across the state.

- Install Intelligent Transportation System (ITS) conduit with all new infrastructure projects
- Prepare strategic plans for Closed Circuit Television (CCTV) camera and Road Weather Information System (RWIS) locations statewide
- Leverage power and communication at existing weigh-in-motion (WIM), dynamic messaging signs (DMS), and call box locations to expand ITS applications across the state
- Consider solar power for lighting and ITS where applicable
- Investigate ice formation prediction technology where applicable
- Conduct highway safety manual evaluation for all future programmed projects
- Develop infrastructure maintenance and preservation plans (including schedule and funding) for all pavement and bridge infrastructure replacement or expansion projects
- Develop standardized bridge maintenance procedures so districts can do routine maintenance work
- Review historical ratings and level of previous investment during scoping of pavement and bridge projects. In pavement locations that warrant further investigation, conduct subsurface investigations during project scoping to determine if full replacement is warranted
- For pavement rehabilitation projects, enhance the amount/level of geotechnical investigations to address issues specific to the varying conditions along the project

- Expand programmed and future pavement projects as necessary to include shoulders
- Expand median cable barrier guidelines to account for safety performance
- Install CCTV cameras with all DMS
- In locations with limited communications, use CCTV cameras to provide still images rather than streaming video
- Develop statewide program for pavement replacement
- Install additional continuous permanent count stations along strategic corridors to enhance traffic count data
- When reconstruction or rehabilitation activities will affect existing bridge vertical clearance, the dimension of the new bridge vertical clearance should be a minimum of 16 feet 3 inches where feasible
- All new or reconstructed roadway/shoulder edges adjacent to an unpaved surface should be constructed with a Safety Edge
- Collision data on tribal lands may be incomplete or inconsistent. Additional coordination for data on tribal lands is recommended to ensure adequate reflection of safety issues.
- Expand data collection devices statewide to measure freight delay.
- Evaluate and accommodate potential changes in freight and goods movement trends given improvements and expansions to the state roadway network.

5 NEXT STEPS

Candidate Solutions identified in Working Paper 5 will advance to be evaluated in multiple ways including a Life Cycle Cost or Benefit Cost Analysis (where applicable), Risk Analysis, and a Performance Effectiveness Analysis. The methodology and approach to this analysis is briefly described below and will be documented in detail in Working Paper 6. Figure 5 illustrates the candidate solution evaluation process.

Life Cycle Cost Analysis – All pavement and bridge candidate solutions have two options, rehabilitate the area of need, or fully reconstruct the issue area or structure. These options will be evaluated through a life cycle cost analysis to determine the best approach for each location where a pavement or bridge solution is recommended. The recommended option will be advanced to the Performance Effectiveness and Risk Analysis evaluations.

Benefit Cost Analysis – Any strategic issue area that resulted in multiple independent candidate solutions will be evaluated through a benefit cost analysis to determine the best solution. The recommended option will be advanced to the Performance Effectiveness and Risk Analysis evaluations.

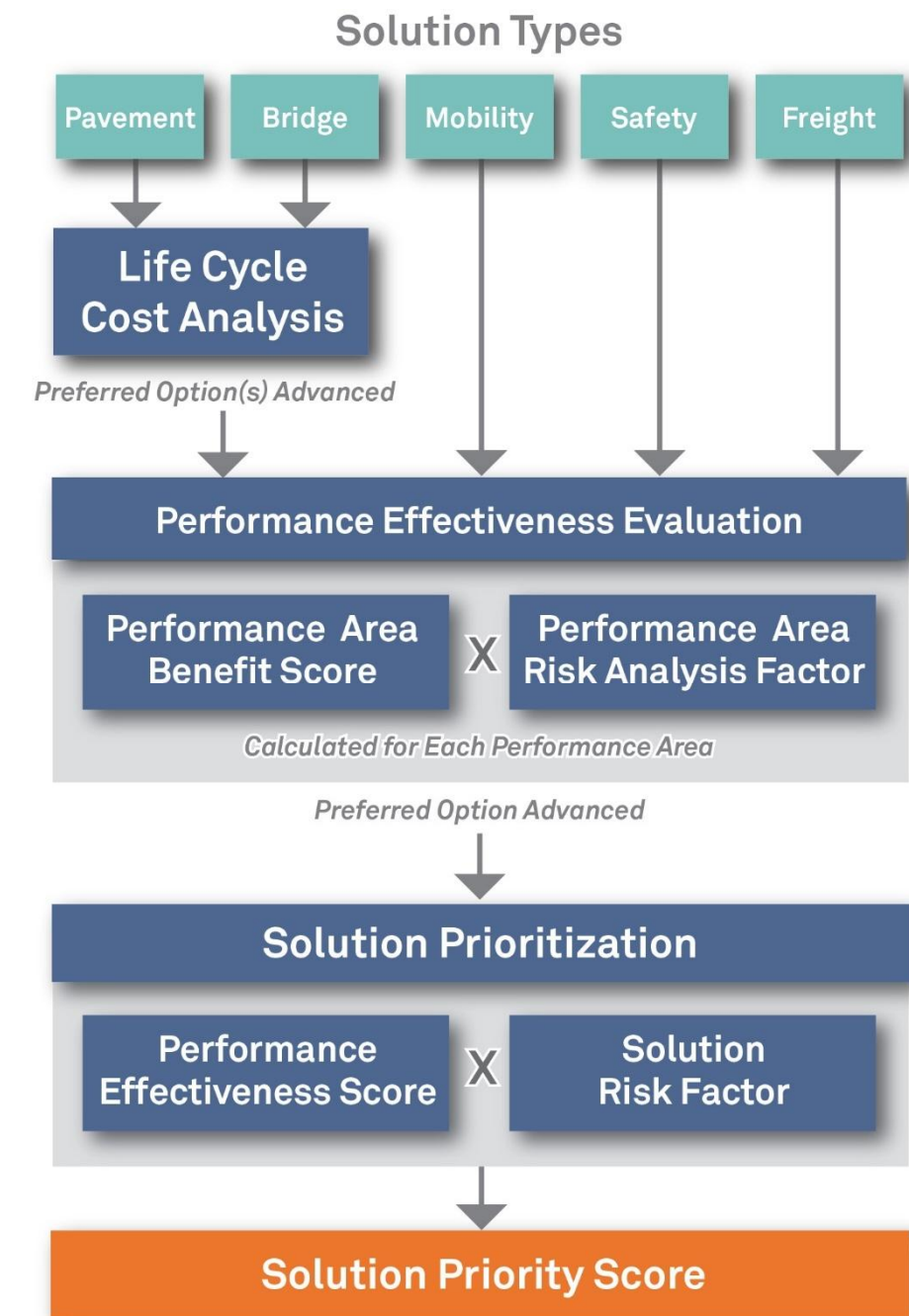
Performance Effectiveness Evaluation – After the LCCA and BCA processes are complete, all remaining candidate solutions will be evaluated based on their performance effectiveness. This process will include determining a performance effectiveness score based on how much each solution increases existing segment level performance scores identified in Working Paper 2 and how much the segment level need in Working Paper 4 is decreased. The results of this evaluation will be combined with the results of the Risk Analysis to determine which solutions have the highest priority in the US 60 | US 70 | US 191 corridor.

Risk Analysis – All candidate solutions that are advanced through the Performance Effectiveness evaluation will also be evaluated through a Risk Analysis process. This process will examine the risk of not implementing a recommended solution in terms of overall corridor performance. The results of this analysis will be combined with the Performance Effectiveness scores to determine the highest priority solutions in the US 60 | US 70 | US 191 corridor.

The highest ranking solutions will become recommended strategic investments for implementation and compared to recommendations developed through other processes, such as the P2P process.

Strategic investments are not intended to be a substitute or replacement for traditional ADOT project development processes where various ADOT technical groups and consultants develop candidate projects for consideration in performance-based programming in the P2P Link process. Rather, these strategic investments are intended to complement ADOT's traditional project development processes with non-traditional projects to address performance needs in one or a combination of the five performance areas of Pavement, Bridge, Mobility, Safety, and Freight. Strategic investments developed for strategic corridors will be considered along with other candidate projects in the ADOT programming process.

Figure 6: Candidate Solution Evaluation Process



APPENDIX A:

Solution Types

PRESERVATION

REHABILITATION

- 0 Rehabilitate Pavement
- 0 Rehabilitate Bridge

MODERNIZATION

GEOMETRIC IMPROVEMENT

- 0 Re-profile Roadway
- 0 Realign Roadway
- 0 Improve Skid Resistance

INFRASTRUCTURE IMPROVEMENT

- 0 Reconstruct to Urban Section
- 0 Construct Auxiliary Lanes
- 0 Construct Climbing/Passing Lane
- 0 Construct Reversible Lane
- 0 Construct Entry/Exit Ramp
- 0 Construct Turn Lanes
- 0 Modify Entry/Exit Ramp
- 0 Replace Pavement
- 0 Replace Bridge
- 0 Widen Bridge
- 0 Install Pedestrian Bridge
- 0 Implement Automated Bridge De-icing
- 0 Install Wildlife Crossing
- 0 Construct Drainage Structure
- 0 Install Center Turn Lane

OPERATIONAL IMPROVEMENT

- 0 Implement Variable Speed Limits
- 0 Implement Ramp Metering
- 0 Implement Shoulder Running
- 0 Implement Signal Coordination/Adjust Timing
- 0 Implement Left-turn Phasing

ROADSIDE DESIGN

- 0 Install Guardrail
- 0 Install Cable Barrier
- 0 Widen Shoulder
- 0 Rehabilitate Shoulder
- 0 Replace Shoulder
- 0 Install Rumble Strip
- 0 Install Safety Edge
- 0 Install Wildlife Fencing
- 0 Remove Tree/Vegetation
- 0 Install Centerline Rumble Strips
- 0 Install Access Barrier Fence
- 0 Install Rock-fall Mitigation
- 0 Install Raised Concrete Barrier in Median

INTERSECTION IMPROVEMENT

- 0 Construct Traffic Signal
- 0 Improve Signal Visibility
- 0 Install Raised Median
- 0 Install Transverse Rumble Strips / Pavement Markings
- 0 Construct Single-Lane Roundabout
- 0 Construct Double-Lane Roundabout

ROADWAY DELINEATION

- 0 Install High-Visibility Edge Line Striping
- 0 Install High-Visibility Delineators
- 0 Install Raised Pavement Markers
- 0 Install In-Lane Route Markings

IMPROVED VISIBILITY

- 0 Cut Side Slopes
- 0 Install Lighting

DRIVER INFORMATION/WARNING

- 0 Install Dynamic Message Sign (DMS)
- 0 Install Dynamic Weather Warning Beacons
- 0 Install Speed Feedback Signs
- 0 Install Chevrons
- 0 Install Warning Signs
- 0 Install Wildlife Warning System
- 0 Install Warning Signs with Beacons
- 0 Install Larger Stop Sign with Beacons

DATA COLLECTION

- 0 Install Road Weather Information System (RWIS)
- 0 Install Closed Circuit Television (CCTV) Camera
- 0 Install Vehicle Detection Stations
- 0 Install Flood Sensors

EXPANSION

WIDEN CORRIDOR

- 0 Construct New General Purpose Lane
- 0 Convert a 2-lane Undivided Highway to a 5-lane Highway (4 Through Lanes with Continuous Two-way Left-turn Lane)
- 0 Convert a 4-lane Undivided Highway to a 5-lane Highway (4 Through Lanes with Continuous Two-way Left-turn Lane)
- 0 Construct 4-lane Divided Highway (Using Existing 2-lane Road for One Direction)
- 0 Construct 4-lane Divided Highway (No Use of Existing Roads)
- 0 Construct Bridge over At-grade Railroad Crossing
- 0 Construct Underpass at At-grade Railroad Crossing
- 0 Construct High-Occupancy Vehicle (HOV) Lane

ALTERNATE ROUTE

- 0 Construct Frontage Roads
- 0 Construct 2-lane Undivided Highway